[Three-Part Webcast Series: Equity and Methods in Campbell Collaboration Systematic Reviews](http://ktdrr.org/training/webcasts/webcast41-43/index.html)

 [**A Short Primer on Power Calculations for Meta-analysis**](http://ktdrr.org/training/webcasts/webcast41-43/43/index.html)

Presented by Terri Pigott, Editor, Methods Coordinating Group, Campbell Collaboration

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ANN OUTLAW: Hello, and welcome to this webcast series, which is brought to you by the Center on Knowledge Translation for Disability and Rehabilitation Research or KTDRR at American Institutes for Research in partnership with the Campbell Collaboration. I'm your host Ann Outlaw, and the Center on KTDRR is funded by the National Institute on Disability, Independent Living, and Rehabilitation Research, also known as NIDILRR.

This is the third part of a three-part webcast series, which focuses on methods for conducting systematic reviews. You can find more information about the webcast series, including links to the previous webcasts, PDFs, and text descriptions of the slides, at our website, which is ktdrr.org.

Today we're joined by Terri Pigott. She'll be giving us a short primer on power calculations for media analysis. Terri is the associate provost for research at Loyola University in Chicago and the editor of the Methods Coordinating Group at the Campbell Collaboration. Terri, thank you so much for joining us.

TERRI PIGOTT: Thank you so much. What I want to talk today about is power analysis and meta-analysis. A common dilemma for researchers conducting a systematic review is when to include a meta-analysis. Researchers often cite low power for meta-analytic tests as a reason for only providing a narrative summary of studies. What I'd like to talk about today is to try to convince you to actually do a power analysis in a meta-analysis even if you feel as if you might have a low power.

In this presentation, I'm going to present a conceptual overview of power analysis and meta-analysis. I'm going to provide a rationale for the importance of power analysis in a meta-analysis. And I'm going to recommend how researchers should present and interpret findings when they suspect statistical power is low in a meta-analysis.

Like all statistical power analyses, a power meta-analysis requires a set of assumptions. If you're doing power analysis in a primary study, there are a set of assumptions you need to have prior to collecting the data to do a power analysis, or in the case of a systematic review, there are a set of assumptions you need prior to conducting the search and eligibility screening in your systematic review.

To compute power, researchers need to have guesses about, for example, the characteristics of a typical study and the number of studies that may be eligible. Researchers might get those guesses by coding a sample of eligible studies for the review to inform those guesses. They might conduct a scoping review or evidence gap analysis, or they may have a deep understanding of the primary studies that are likely to be included in the review.

In order to conduct power analysis for significance tests of the mean effect size in a meta-analysis, there is information you need, both at the level of this research synthesis itself and from the eligible primary studies that you think are going to be in the review. At the level of the research synthesis, we need to know the type I error rate you want to use for your test to the mean effect size-- for example, alpha 0.05 for a one-tailed test.

You also need to know the effect size of practical or clinical significance that will be important in your systematic review. We need to know the number of studies that we expect that will be eligible for the meta-analysis, and if you're using a random effects model, we need the estimate of the variance component-- in other words, the between-studies variance. At the level of the primary studies or the eligible studies for their review, we also need to know something about the typical within-study sample size.

If we're interested in power of other meta-analytic tests, we actually need guesses about some other information. If we're interested in doing a test of homogeneity, at the level of the synthesis, we also need to know the expected heterogeneity or amount of variation we expect among effect sizes. If we think we're going to do a test of a categorical moderator to see how a categorical moderator might be related to variance across effect sizes, we also need to know the number of studies within each group that are defined by that moderator. We need to know the magnitude of the difference we expect between the groups defined by the categorical moderator, and again, in random effects, we're going to need to know something about the between-studies variance or the variance component.

Tests for a meta-regression are a little bit more complicated. The power of tests for meta-regression are more complicated in a meta-analysis. Here, we really need the full covariance matrix for the predictors, and in this case, as you might guess, it's very difficult to conduct power analysis for meta-regression prior to collecting studies. But I can give you some general observations about power and meta-analysis, and then I will point you to some resources later on in this webcast where you can actually figure out how to do a power analysis.

In general, the larger number of eligible studies in a meta-analysis is going to give us higher power for our test for meta-analysis. Larger sample sizes within studies, so larger primary studies included in the meta-analysis, will also give us higher power in our tests in a meta-analysis. The larger the mean effective interest in our synthesis that we think is of clinical significance will also lead to higher power. In general, random effects meta-analysis has lower power than doing a fixed-effects meta-analysis.

Tests of moderators that may be related to effect size variance, using either categorical models or meta-regression, are likely to have low statistical power without a large number of studies. And again, as I said in the prior slide, methods for computing power for meta-regression require information that we normally do not have prior to conducting a review.

But given the difficulties in conducting power analysis prior to doing a meta-analysis, why would it be important to do a prospective of power analysis? Well, for example, prospective power analysis can really help us understand the body of evidence we might have in a given context. For example, if we expect a lot of heterogeneity among studies because the review question is a broad or the intervention may be a difficult one to implement, then we should know ahead of time that we will need a lot of studies to detect a clinically important effect size.

We can also use power analysis to provide information about those number of studies we might need given the assumptions we make about the body of evidence in a review. Prospective power analysis can also provide context if we find that our statistical tests are not significant. As I said a couple slides ago, tests of moderators are generally of low power if there's a small number of eligible studies, but we also have to remember, then, that finding that a moderator is not significantly related to effect size variation does not mean that there is no relationship, particularly when we have few studies. Power analysis can help us know if we have sufficient power to detect associations between moderators and variants across effect sizes. So we should always remember that, with low power, we should not conclude that there is no relationship between a moderator and variation among effect sizes. We may need more evidence in that case.

So one general recommendation I would make to you as you're reporting meta-analysis or meta-analytic results, if you suspect low power, is that you should always report the mean effect size and its confidence interval because confidence intervals provide information about the minimum and maximum likely size of the effect or, in other words, the worst and best case scenarios for the effectiveness of an intervention because, again, the lack of statistical significance of a meta-analytic test does not mean that we don't have an effect or that the moderators are not related to effect size variation. We just may need more studies to conduct this test more reliably.

Here are some resources for learning how to actually conduct power analysis and meta-analysis. If you're new to this area, I would start with the Valentine Pigott and Rothstein that actually walks you through how to conduct tests of power in a meta-analysis. And then if you're interested in more statistical background of power in meta-analysis, the final three articles I cite here-- that two Hedges and Pigott and the Jackson and Turner-- give you more technical background and more theoretical background into power analysis and meta-analysis. Thank you very much for your time, and please do not hesitate to contact me for any questions you might have.

ANN OUTLAW: Thank you very much, Terri, for all of that information, and thank you everyone for attending the final webcast in our three-part series on equity and methods in Campbell Collaboration's systematic reviews. If you missed the previous webcasts in the series, you can find links to them on our website, which is ktdrr.org. And after you've viewed all three webcasts in the series, I encourage everyone to fill out an evaluation form at the link at the bottom of this slide. We will email it to all of those who registered, and this evaluation really helps us to plan our future events. And you can also ask your questions to the presenters and include your email address if you would like them to get their answers back to you.

Before we close, I'd like to thank our funder, which is the National Institute on Disability, Independent Living, and Rehabilitation Research, or NIDILRR, for providing funding for this webcast series. And we look forward to your participation in future events. Thank you so much.